SCIENCE AND TECHNOLOGY BENEFIT ANALYSIS

Idaho Operations Office – Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho LLC

Expert System for TRU Waste Assay Data Validation Review

A Data Review Expert System (DRXS) developed by INEEL engineers and scientists provides the INEEL Transuranic Waste Program (ID-WM-103) with an automated technical review and validation process for data obtained from non-destructive assay (NDA) of transuranic (TRU) waste drums. The technology is currently being deployed and will be completed in September 2001 upon conclusion of the testing/certification process. The DRXS will reduce the risk of human error, reduce the time required to conduct, and reduce the human technical expert resources necessary to perform the independent technical review required for validation of TRU waste NDA data. The ultimate benefit is increased assurance of successfully completing the INEEL 3100 m^3 project. Additionally a version of this expert system is being deployed by the INEEL in support of NDA data validation review at the Los Alamos National Laboratory (LANL).

The computer based DRXS performs all aspects of the independent technical review (ITR) process, in place of human experts. The DRXS automatically accesses the selected data and performs the calculations and comparisons necessary to identify suspect data and print out appropriate messages that explain why the data is suspect. Additionally, the review process is easily traceable by scientists because the ITR screening process and results are electronically recorded.

The independent review of TRU waste characterization data is required to ensure that NDA systems are operating within prescribed parameters and that the TRU waste NDA characterization data is representative and in accordance with the data quality objectives to certify waste for shipment to WIPP. The SWEPP operation utilizes a combination of NDA systems to obtain data required on the radionuclides present in TRU waste drums. Because of the many types of wastes, large volumes, and physical differences it is necessary that NDA systems are correctly calibrated for each stream to ensure engineers that the data is meaningful and representative. The independent technical review (ITR) provided by the Data Review Expert System is operationally needed and required as a quality assurance step toward certifying TRU waste characterization data for shipping waste to WIPP.

The deployment of the DRXS helps satisfy the INEEL S&T need ID-3.1.06 "Advanced Nuclear Assay for CH-TRU Waste Drums".

Qualitative Benefit Analysis		
Programmatic Risk	●	The DRXS performs reviews consistently and accurately to the defined data objectives. This reduces potential for human errors in the process (e.g. data reading errors, hand computational errors, incorrect parameter comparisons, neglected or incorrectly recorded suspect data flags and messages, etc.) and provides a readily retrievable and traceable electronic record.
Technical Adequacy	◒	The DRXS automatically accesses selected data and performs the calculations and comparisons necessary to identify suspect data and print out appropriate messages that explain why the data is suspect.

Safety	○	No change to worker or public safety.
Schedule Impact	●	The schedule impact is significant. Utilizing the DRXS frees up the time of the few highly qualified human experts to focus upon the subsequent identification of suspect data. The review process of a twenty drum batch of assay data (approximately 90 pages of data) is completed by the DRXS in less than 5 minutes, while an experienced qualified expert will require 2 to 4 hours.

●	◒	○	◓	◉
Major improvement	Some improvement	No change	Somewhat worse	Major Decline

Quantitative Benefit Analysis	
Cost Impact Analysis	Direct cost reduction savings due to DRXS elimination of human expert time for the ITR screening is estimated at $300k over the remaining 15 month life cycle of the project ($240k on an annual basis). Basis for estimate is eliminating 4 hrs of human ITR screening per waste batch at $100/hr. It is difficult to quantify the impact of eliminating the potential human error in terms of potential dollar costs avoided. A rough order of magnitude estimate would be greater than $1M by assuming a typical 5% human error could lead to a rework of NDA characterization on 5% of the drums. Additionally, cost avoidance is achieved by supporting the 3100 m^3 project schedule, i.e., avoiding capital investments and negative aspects of not meeting the Settlement Agreement milestones.

ESTIMATE BASIS FOR: Expert System for TRU Waste Assay Data Validation Review

Worksheet 1: Operating & Maintenance Annual Recurring Costs

Expense Cost Items *	Before (B) Annual Costs	After (A) Annual Costs
1. Equipment	$ -	$ -
2. Purchased Raw Materials and Supplies	$ -	$ -
3. Process Operation Costs:		
Utility Costs	$ -	$ -
Labor Costs (for screening only, burdened)	$240,000	$ -
Routine Maintenance Costs for Processes	$ -	$ -
Subtotal	$240,000	$ -
4. PPE and Related Health/Safety/Supply Costs	$ -	$ -
5. Waste Management Costs:		
Waste Container Costs	$ -	$ -
Treatment/Storage/Disposal Costs	$ -	$ -
Inspection/Compliance Costs		$ -
Subtotal	$ -	$ -
6. Recycling Costs		
Material Collection/Separation/Preparation Costs:		
a) Material and Supply Costs	$ -	$ -
b) Operations and Maintenance Labor Costs	$ -	$ -
Vendor Costs for Recycling	$ -	$ -
Subtotal	$ -	$ -
7. Administrative/other Costs	$ -	$ -
Total Annual Cost:	$ 240,000.00	$ -

* See attached Supporting Data and Calculations.

ESTIMATE BASIS FOR: Expert System for TRU Waste Assay Data Validation Review

1. Design/Development	$	70,000
2. Purchase	$	-
3. Installation	$	-
4. Other Capital Investment (explain)		
Subtotal: Capital Investment= (C)	$	70,000
INSTALLATION CAPITAL EXPENSES		
1. Planning/Procedure Development	$	-
2. Training	$	-
3. Miscellaneous Supplies	$	-
4. Startup/testing (certification testing and Apps Mods)	$	80,000
5. Readiness Reviews/Management Assessment/Administrative Costs	$	-
6. Other Installation Operating Expenses (explain)	$	-
Subtotal: Installation Operating Expense = (E)	$	80,000
7. All company adders (G & A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)(if not contained in above items)	$	-
Total Project Funding Requirements=(C + E)	$	150,000

Useful Project Life = (L) 1.25 Years Time to Implem 6 Months

Estimated Project Termination/Disassembly Cost (if applicable) = (D) $ -

(Only for Projects where L<5 years; D=0 if L>5 years)

TOTAL LIFE-CYCLE COST SAVINGS CALCULATION FOR IPABS-IS

(Before - After) x (Useful Life) - (Total Project Funding Requirements + Termination)

Total Life Cycle Cost Savings Estimate = (B - A) x L - (C+E+D)

RETURN ON INVESTMENT CALCULATION

Return on Investment (ROI) % =

$$\frac{\textit{(Before - After) - [(Total Project Funding Requirements + Termination)/Useful Life]}}{\textit{[Total Project Funding Requirements + Project Termination]}} \textit{ x 100}$$

$$ROI = \frac{(B-A)-[(C+E+D)/L}{(C+E+D)} \times 100 = 80\%$$

O&M Annual Recurring Costs:				Project Funding Requirements:			
Annual Costs, Before=	$ 240,000	(B)		Capital Investment=	$ 70,000	(C)	
Annual Costs, After=	$ -	(A)		Installation Op. Exp=	$ 80,000	(E)	
Net Annual Savings=	$ 240,000	(B-A)		Total Project Funds=	$ 150,000	(C+E)	

Note: Before (B) and After (A) are Operating & Maintenance Annual Recurring Costs from Worksheet 1.

ESTIMATE BASIS FOR: Expert System for TRU Waste Assay Data Validation Review

GENERAL

Years of extensive NDA systems R&D and knowledge of the underlying physical mechanisms governing the behavior of the instruments have resulted in a body of expert knowledge. This includes some generally accepted rules to guide and standardize the assessment of the "acceptability" (quality) of the radio-assay data. These rules/guidelines involve over 150 parameter limit and ratio limit value checks to be conducted manually by the expert independent reviewer(s) in "screening" the radio-assay data for potential problems (see EDF 840). If the specific value limits of these screening checks and guidelines are exceeded, the reviewer "flags" that area for further human expert review and ultimate judgement on technical acceptability.

INITIAL CAPITAL INVESTMENT

The costs to complete applications development and deploy the expert system application for the INEEL 3100 m^3 project are approximately $150k. The annualized rate of return on investment (ROI) for this deployment is 80% considering direct cost savings alone (not including potential savings from error cost avoidance) as calculated per the attached worksheet 2.

INSTALLATION AND START-UP

By the simplest definition a technology deployment is complete when the technology is in use by operations. In the case of TRU waste operations, however, use of this simple definition would unfairly penalize the INEEL's objectives in promoting the deployment of technology for improved operations solutions. The stringent QA program requirements for processes/systems that are certified to prepare wastes for disposal at the WIPP require completion of a formal certification audit by the EPA (Environmental Protection Agency) and CBFO (Carlsbad Facility Office) before official recognition of operations compliance. The time required to complete the formal audits is not within the INEEL's control. The audits cannot be completed until the completion of all the technical steps necessary to prove technology functional performance will satisfy all operations requirements and is ready for use. The latter is the intended objective of technology deployment projects and will be used as the point of completion definition for the DRXS technology deployment.

The DRXS software application development has been completed, software installed, and dry-run testing completed. The formal software quality assurance program documentation for implementation has been prepared and is currently in the document control final review and approval cycle. The formal software test plan (STP) testing for confirmation of compliance with QA requirements are planned to be completed in August, along with the issue of the controlled software documentation. The deployment of the DRXS for operations implementation will be considered complete and available for operations implementation at that point. Completion of formal audit by the National TRU program will follow (anticipated in Oct).

TRADITIONAL (BASELINE) TECHNOLOGY/METHOD

The current baseline process utilizes highly qualified, technical experts (degreed in nuclear physics, engineering, and others experienced in the principles and processes underlying the non-destructive assay measurement systems, technology, and waste types) for the independent technical review of the NDA data. In the screening phase of the independent technical review (ITR), these human experts must: 1) visually examine a large number of printed pages of relevant parameter data in small print, 2) perform selected repetitive calculations on the data to compute a value or obtain selected ratios, 3) mentally compare data parameter values against the "screening" parameter values and

ratio values for acceptability, and 4) record notations on the hardcopy that identify potential problem assay data and why the data was flagged as suspect. This screening process is undertaken repetitively by the human expert on the NDA data from each drum in a twenty-drum batch and the batch QC drums (1 replicate and 2 known calibration drums). The data flagged as suspect in this screening phase of the technical data review is then subject to additional human expert review for ultimate judgement on technical acceptability. This latter phase of review on flagged "suspect" data is referred to as the Expert Technical Review (ETR).

NEW TECHNOLOGY/METHOD

The computer based "Data Review Expert System" (DRXS) incorporates into software all aspects of the screening portion of the independent technical review process and conducts the ITR review process automatically, in place of the human experts. The DRXS directly accesses the selected drum batch assay data files, conducts the necessary calculations and defined parameter value comparisons, identifies suspect data, and prints out appropriate notification messages that explains why the data is flagged as suspect. The DRXS review process is recorded automatically providing an electronically retrievable audit trail record of the ITR screening and results. The DRXS performs this review process consistently and accurately to the defined rules/guidelines. The DRXS eliminates the inherent human expert-to-expert variations and potential for human errors in the process (e.g. data reading errors, hand computational errors, incorrect parameter comparisons, neglected or incorrectly recorded suspect data flags and messages, etc.). It also provides a readily retrievable electronic record of the review process. The DRXS completes this process on a twenty drum batch of assay data (approximately 90 pages of data) in less than 5 minutes, while an experienced qualified expert will require from 2 to 4 hours. Utilizing the DRXS additionally frees up the time of the few highly qualified human experts to focus upon the subsequent Expert Technical Review of identified suspect data, and other non-repetitive tasks requiring the flexibility of human expert judgement.

COST SAVINGS/COST AVOIDANCE/RISK REDUCTION

Direct cost reduction savings due to DRXS elimination of human expert time for the ITR screening is estimated at $300k over the remaining 15 month life cycle of the project ($240k on an annual basis). Basis for estimate is eliminating 4 hrs of human ITR screening per waste batch at $100/hr. Elimination of the potential for human error improves confidence in the data validation review and quality assurance process on the waste assay data. It substantially reduces the risk of a potential audit finding error in the ITR process, which would potentially require costly process down-time to investigate and rework the NDA data and the ITR process. It is difficult to quantify the impact of eliminating the potential human error in terms of potential dollar costs avoided. A rough order of magnitude estimate would be greater than $1M by assuming a typical 5% human error could lead to a rework of NDA characterization on 5% of the drums.

SCIENCE AND TECHNOLOGY BENEFIT ANALYSIS
DEPLOYMENT APPROVALS

Technology Deployed: **Expert System for TRU Waste Assay Data Validation Review**

Date Deployed: **September 2001**

EM Program(s) Impacted: **Transuranic Waste Program**

Approval Signatures

[signature] 9-11-01

Contractor Program Manager Date

N/A

Contractor Program Manager Date

[signature] 9-20-01

DOE-ID Program Manager Date

N/A

DOE-ID Program Manager Date